I.S.T.D./F/457 A (Restricted)

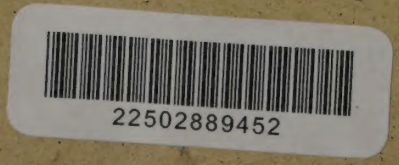
THE EFFECT OF HEAT
AND
HUMIDITY ON TROOPS
IN
THE FAR EAST

INTER-SERVICE TOPOGRAPHICAL DEPARTMENT

March 1945

RESTRICTED

This book is for the use of persons in H.M. Service only and must not be shown, or made available, to the Press, or any member of the public.



THE EFFECT OF HEAT AND HUMIDITY ON TROOPS IN THE FAR EAST

(SUPERSEDING EDITION DATED JULY, 1944)

Inter-Service Topographical Department
March 1945

C O N T E N T S

THE EFFECT OF HEAT AND HUMIDITY ON TROOPS IN THE FAR EAST

(1) Vulnerability of troops to heat and humidity

Health in the tropics has long been known to require hygienic protection, for it is vulnerable, especially in the case of newly-arrived men, to bacillary and parasitic diseases. Climate of itself, however, also materially affects health, and although in healthy persons this effect may vary to some extent individually, there are definable limits of heat, humidity and wind beyond which human beings cannot work and, at higher degrees, when life becomes impossible.

(2) Sources of body heat

Man, unlike many animals, maintains a nearly constant temperature which, in the mouth, is usually about 98.4° F. and, in the deeper tissues, approximately 99° F. This body heat is produced and maintained partly by external conditions such as the heat from the sun, also by work and exercise and other physiological processes. For the purpose of this account we need consider as body heat producers only the heat derived from the sun's rays and that derived from activity.

The sun's rays may be classified into the infra-red and red, which produce heat; the orange to indigo, visible, rays which produce light; and the violet and ultra-violet which are stimulating in small quantity but which, in excess, can be painful. The heat rays are those responsible for heating the ground and persons and can produce heat-stroke (q.v.); the visible-ray range in general produces no heat disease but only glare and slow dark adaptation.

A great deal of research has been carried out on the reaction of the human body to the sun's rays and on the effects of work performed in heat. For example, it has been found that the naked body, when exposed to the very hot sun, absorbed three times as much heat as is produced by a body at rest. Another experiment showed that a soldier at rest produces 1.2 calories of heat a minute, but that the same man marching with a 65 pound pack produces 8 calories a minute. This marching rate would raise the body temperature 1° C. (1.8° F.) in nine minutes if no heat loss occurred.

Now, if heat is not lost from the body in the usual ways, so that the balance of heat in the system is disturbed, the body temperature will rise and serious, even fatal, pathological conditions will ensue.

(3) The mechanics of loss of heat from the body

The normal means by which heat is dissipated from the body are:

(a) By convection and radiation to the surrounding air;
(b) by conduction to adjacent objects;
(c) by the exhalation of water-vapour from the lungs and the evaporation of water from the skin;
(d) by the discharge of urine, etc.; and
(e) by drinking cool water, etc.

All of these factors and their inter-relationship are important. The first three are largely influenced by clothing, which to some extent insulates the body from the conditions of the

surrounding air and adjacent objects, such as furniture, etc., and from the wind. Under normal cool conditions actually more body heat is lost by convection, radiation and conduction than in any other way.

Clothing as a rule is composed of materials which are bad conductors of heat and the heat loss may be diminished by no less than 47 per cent. Wet clothing, on the other hand, is a good conductor because of the water in the interstices, hence the danger of chills while wearing damp clothes. This fact is well known to the old resident in the tropics. In peace-time conditions in the tropics, the clothing is of importance as it can be made suitable to the needs of the day and as, in addition, exposure to the sun and outdoor atmosphere can be avoided at the hottest times of the day. Under operational conditions, however, these mollifications cannot necessarily be obtained. Apart from equipment which the troops must carry, special anti-malarial precautions and protections for the feet and legs against, for example, leeches and snakes, make troops unable to follow the most desirable courses of avoiding the two-way effects of radiation and conduction. Under these conditions a greater strain is inevitably thrown on the last three means of heat regulation and loss listed above.

(4) The process of perspiration

The process of perspiration, which is not so simple as it at first would appear, may be defined as the passage and evaporation of water from the surface of the skin.

The principal avenue by which water reaches the surface of the skin is provided by the sweat glands, but a considerable amount of water is continually lost by what is known as insensible perspiration. This occurs in two ways:

(a) By the exhalation of saturated water vapour, at about 91½° F., from the lungs and air passages, as can be clearly seen in cold weather. It amounts in ordinary circumstances to nearly one-third of the insensible water loss.

(b) By the passage of fluid from the tissues through the skin. This is a physical process quite independent of the sweat glands, and persons without any sweat glands can discharge by this means as much fluid as normal people do.

The rate of this insensible perspiration is fairly uniform over the whole body surface, except for a few regions such as the palms of the hands and the soles of the feet, and the rate does not change very much although the rate of expiration in the breath naturally varies with activity. The total quantity from this insensible perspiration is said to be approximately parallel to the resting metabolism.

The action of the sweat glands, on the contrary, is not passive but varies widely and the glands are under nervous control. They come into play for two reasons; emotional, as is commonly known from "cold sweats" and the nervous perspiration on the palms of the hands and the forehead; and heat regulatory, which is probably also a nervous reflex.

With a rise in temperature, or with increase of activity, the principal of all these methods of heat loss and regulation consists of the sweat glands of the body which function more or less equally.

The common sensation of increased perspiration in the armpits (axilla) and the pubic region (perinaeum) is in fact an illusion since the glands in these regions probably produce rather less than the glands of more exposed parts. The sensation is due largely to limited evaporation which may, however, be troublesome in service personnel (see Intertrigo, p. 9).

(5) Nature of the skin

The nature of skin itself has some bearing on the question of sweating. It has been proved that dark skin absorbs more energy than white skin. The skin of Europeans that has become tanned is protected against the painful effects of ultra-violet radiation, but it is actually more susceptible to the heating action of the sun. In sunlight, therefore, a person with a black or tanned skin will absorb more energy, and so be heated more, than a person with a fair skin. Though it follows from this that an unacclimatized person will not be heated so much as the older resident, his sweating and salt loss are not so well regulated, and as both of these are factors that are so much increased in activity in sun as compared with in shade, it is recommended that only acclimatized and hardy persons should expose much of their body to the sun, particularly during strenuous physical work.

The discomfort of the unacclimatized man is only partially connected with perspiration control. There are often evidences of circulatory failure and these may appear before the body temperature has reached a high level. The heart rate rises, the blood pressure falls, and faintness is apt to be experienced.

(6) Loss of water and salt from the body

Sweat contains salts in solution, of which the most important is sodium chloride (common salt).

Sweating is therefore expensive to the body in the loss of both water and salt. Deprivation of either produces serious effects, and the restoration to the body of the amounts of both the water and salt lost in the sweat is of fundamental importance in the maintenance of physical efficiency in a hot climate and in the prevention of heat hyperpyrexia.

(a) Loss of water from the body

If the water lost in the sweat is not replaced, the water content of the body decreases progressively and with it the capacity to work in the heat. Physical efficiency is practically lost by the time dehydration reaches the extent of 10 per cent. of the body weight and death follows if dehydration exceeds 20 per cent. of the body weight.

Dehydration of itself causes a specific type of heat exhaustion (see p. 6), but the great danger to which dehydration exposes an individual in a hot climate is heat hyperpyrexia. The reduced rate of sweating and the concentration of the blood with consequent reduction in the blood flow through the skin both interfere with heat loss and lead to a progressive rise in body temperature.

Therefore, if physical efficiency is to be maintained, the water lost in the sweat must be made good. No absolute figures can be given for a man's water requirement in a hot climate, for this will vary with the environmental temperature and the amount of physical exertion undertaken.

Thirst is a good, but not an accurate, index of water requirements, and men working in a hot climate may on occasion replace, by the water they drink voluntarily, less than two-thirds of the amount of water lost in the sweat during the day.

Physical efficiency for work in the heat is therefore likely to be increased if men are encouraged to drink even more water than they require to quench their thirst. Deprivation of water quickly leads to physical deterioration, and the provision of plenty of drinking water is therefore essential if men are to work efficiently in the heat. Even men acclimatized to heat cannot be trained to go with less than their physiological water requirements, and this dangerous fallacy is mentioned only to be denounced. Restriction of water during work in the heat is not only not beneficial, but is definitely harmful. A guide to the amount of water which must be provided is given by the amount of sweat lost during work in the heat, to which must be added the water lost in the urine, the expired air and the stools. Men doing about three hours' moderate work under desert conditions lose anything from $1\frac{1}{2}$ - 2 gallons of water per day, and when hard work is done, the loss may be anything up to about 3 gallons. The water losses in tropical (humid) conditions are of the same order, but somewhat less.

(b) Loss of salt from the body

It has long been known that a principal constituent of sweat is common salt (sodium chloride), but experiments carried out under the trying conditions of labour in the desert at Boulder City, Nevada, have shown that sweat is more dilute than had been previously thought. At least one of the members of the experimental party, although drinking profusely, in the hot desert atmosphere of Boulder passed no urine for the first two or three days. During this time analysis of sweat showed that the percentage of salt was high. Acclimatization was, however, fairly rapid. The passing of urine with some salt content soon recurred and the percentage of salt in the sweat declined. There may, however, be individual differences in this respect.

The point is of some importance, for the salt loss of the body fluids must be balanced. Stokehold and factory work in high temperature conditions has shown the great advantage of providing the workers not only with copious supplies of fluid but also of adding salt to the water (0.1 per cent).

This loss of salt is a human physiological shortcoming, for man, unlike the horse and the ox and other animals which seek salt licks, does not crave for salt even when it is badly needed in his body. Should the salt loss continue, for example in troops in operations in hot climates, the disease of heat cramp (see p. 7) may develop.

One of the most serious effects of depletion of the body's salt content is that it lessens the capacity of the tissues to retain water. It is essential for life that the concentration of salt in the body fluids is kept at a constant level. If therefore the amount of salt in the body is reduced, the amount of water in the body has to undergo a corresponding reduction so that the concentration of salt in the body fluids may remain constant. This adjustment leads to dehydration and so predisposes to the onset of heat hyperpyrexia.

(7) Humidity and its effects

Unfortunately temperature and acclimatization are not the only factors to be considered. It is doubtful whether the races now living in the tropics were originally better suited to that environment than the white man but through continuous selection or adaptation they appear to have acquired a better survival value. Experience has shown that the white man can become well adapted so as to have a fairly comfortable life in the deserts but there is so far no evidence that he has become fully adapted to life in hot climates that are also humid. Humidity is a highly important factor and for this reason the readings of the wet-bulb thermometer in the tropics are more important in some respects than those of the dry thermometer.

The wet-bulb thermometer has its bulb wrapped in a damp wick which dips into water; the rate of evaporation of water from the wick and the consequent cooling of the wet-bulb are dependent on the relative humidity of the air. This relative humidity, which is of great physiological importance, can be calculated from a table (Glaisher's table) from the readings of the wet and dry bulb thermometers.

The physiological adaptation of man to life in the wet tropics appears to be a slow process and there are certain fundamental reasons for this. One reason is the uniformity of the temperature, since, although a variable temperature can be stimulating, a constant temperature is depressing. While the temperature of the desert, as recorded by a dry thermometer, may exceed that of the jungle by several degrees, the wet-bulb thermometer at the same time will record a higher temperature in the jungle than in the desert. Figures might be:

	Dry-bulb temp.	Wet-bulb temp.	Relative Humidity
Desert.....	104° F. (40° C.)	71.8° F. (22° C.)	26%
Jungle.....	93.2° F. (34° C.)	87.8° F. (31° C.)	80%

As the saturation of the air with water vapour increases, the rate at which water vaporizes from the skin decreases. The hard worker in the desert has dry clothes and a dry skin, owing to the rapid evaporation, but in the tropics his clothes are sticky and his skin is wet. This latter condition, though endurable, is very uncomfortable.

Haldane found that the temperature of a man began to rise when he was:

(a) At rest in still air when the wet-bulb thermometer was 88° F. or over;

(b) at rest in moving air when the wet-bulb thermometer was 93° F. or over;

(c) doing moderate work in still air when the wet-bulb thermometer was 78° F. or over;

(d) doing moderate work in moving air when the wet-bulb thermometer was 86° F.

(8) Limits of endurance

The rate of air movement is characteristically high in the desert and low in the jungle. This is of great importance to man, for slow air movement means that the film of air surrounding the body has a significantly higher saturation with water vapour than the air mass. Thus evaporation is reduced and the skin temperature therefore raised.

These conditions inevitably place a heavy burden on the heat-regulatory mechanism, and the increased burden on the heart, especially in unfit or unacclimatized men, is a most notable physiological factor.

It is stated that in calm air the human body can support an air temperature of 100° F. if the relative humidity is less than 90 per cent.; 120° F. if humidity is less than 40 per cent.; 140° F. if the humidity is under 15 per cent. Death will occur at 128° F. if the wind velocity is 20 miles per hour, and at 117° F. if the wind velocity is 56 miles per hour.

(9) Other effects of heat

The stresses of life in high temperatures are not merely those concerned with perspiration. In acute failure such as that due to excessive salt loss or to a steadily rising temperature, the sweat glands may be primarily at fault; but the chronic effects of heat may be observed even when sweat secretion and temperature regulation are adequate. Failure that comes after days or weeks of exposure may be due to a downward trend in the 24-hour cycles that describe the course of fatigue and recovery. Anyone exposed to high temperature should take warning if his degree of exhaustion increases with each day of active service and his degree of recovery decreases with each night of rest.

Experiments with normal and healthy persons in the tropics have shown that in any case there are changes in the general metabolism, most of which, however, sooner or later disappear on a measure of acclimatization being reached.

(10) Climatic diseases

The chief climatic diseases in the Far East are: dehydration, heat-stroke, heat cramp, sun traumatism, heat low fever, heat oedema, tropical neurasthenia, prickly heat, cacophoria tropicalis, chills, intertrigo, tropical photophobia, tropical cheiropompholyx, craw-craw, and sun dermatitis.

(a) Dehydration

If the water lost in the sweat is not replaced by water drunk, the body becomes dehydrated, and this gives rise to a specific form of heat exhaustion. Where men sweat profusely as a result of work in a hot climate, symptoms of dehydration may appear after only a few hours of work.

Dehydration is marked by dizziness, breathlessness, tingling in the arms, lassitude, intense sleepiness and later collapse.

The symptoms are rapidly and completely alleviated by drinking plain water.

(b) Heat-stroke

Heat-stroke may be divided into two clinical varieties, heat hyperpyrexia and heat exhaustion.

(i) Heat hyperpyrexia

This is always serious. Its onset may be sudden or gradual. Early warning symptoms include the frequent desire to pass water, dryness of the skin, giddiness, drowsiness, headache, intolerance to light, and tingling and cramp of the limbs due to chloride deficiency and dehydration. If the condition is not treated, the pulse quickens and becomes irregular, the skin becomes hot and dry, and the temperature raised. Delirium, coma or convulsions may ensue.

Treatment, which consists of measures of lowering the temperature, preventing cardiac failure and restoring the amount of chlorides, will be found in War Office Memoranda on Medical Diseases in Tropical and Sub-Tropical Areas, 1942, p. 122 - 3.

It is important to remember that heat hyperpyrexia may return a few days after the first attack. A man who has suffered from it requires at least three weeks' careful treatment before he is allowed to go about again.

(ii) Heat exhaustion

Heat exhaustion will often overtake heavily-laden soldiers on the march in hot weather, and when the man is relieved of his equipment and has a rest, he may recover rapidly. The condition is really a fainting attack and may progress to prostration, with giddiness, nausea and clammy sweat. The pulse is thready, the breathing shallow and the pupils dilated; unconsciousness and even death may follow. After recovery headache may be troublesome and mental confusion may be noticeable.

Heat exhaustion is not a feverish condition. Indeed, the temperature may be subnormal, but there is always the danger of hyperpyrexia developing in the next few days. The patient must therefore be treated adequately and kept under favourable conditions. He, also, may require at least three weeks' careful treatment before he is allowed to go about or travel again.

Recent researches by Ladell, Waterlow and Hudson (1944) suggest that two types of heat exhaustion may be distinguished. The first type is characterized by dehydration, vomiting, cramp and low urine, and the disease is regarded as a salt deficiency dehydration in those who normally have a high concentration of chloride in the sweat. The second type is characterized by defective sweating, increased micturition and desquamating prickly heat. This type may be a fatigue phenomenon associated with a prickly heat skin change. As Marsh (1945) points out this distinction, though of interest, does not affect the treatment.

(c) Heat cramp

This results from excessive sweating and the accompanying loss of salts from the body. It may accompany heat hyperpyrexia but occurs more usually alone. The onset may be sudden and the person may fall on the

floor in agony with intermittent pains in the legs, thighs, abdomen and other parts of the body. Treatment consists of giving liberally water containing salt (0.1 to 0.2 per cent.).

(d) Sun traumatism

Exposure to the sun may result in two clinical conditions like those of heat-stroke, namely sunstroke, with high fever, and sun exhaustion, with little or no fever. Both these conditions, if their clinical entities are admitted, are due not to heat but to the direct rays of the sun on the head.

Sunstroke is characterized by severe headache, a full and rapid pulse, dry skin and, at times, vomiting and delirium.

Sun exhaustion, like heat exhaustion, is a fainting attack (syncope).

The after effects of sun traumatism may render a man unfit for service for some days or even weeks.

Recent research suggests that sun traumatism is due not to the short-wave light rays of tropical sunlight, but to the long-wave heat rays. Exposure to the sun may cause only headache, often at the back of the head, with or without giddiness and nausea. Many authorities regard "sunstroke" as a synonym of heat-stroke, and the French equivalent term, coup de soleil, is used for sun dermatitis.

(e) Heat low fever

This is a low, intermittent fever of long duration which occurs in persons in poor health and under the influence of continued high air temperature and a degree of atmospheric humidity. The temperature may rise every day for months to 100° F., or less, though the patient may feel little discomfort. Rest and a change of climate will effect a cure.

(f) Heat oedema

This term has been applied to a condition in which there is oedema (swelling) of the legs and feet due to heat. The legs and feet are swollen and slight pitting may be produced on pressure. There may be discomfort, and larger boots or shoes may have to be worn. The general health remains good and the reflexes are normal. A more severe type is known in which the swelling may be enormous. In both forms the symptoms disappear completely when the temperature becomes lower.

(g) Tropical neurasthenia

This does not differ from the neurasthenia elsewhere but it is usually more marked and more common. Malaria and other diseases may be predisposing factors but life under tropical conditions and the lack of seasonal changes are probably the principal causes. Tropical heat engenders insomnia which may lead to psychoneurosis.

(h) Prickly heat

This condition occurs in all tropical climates. It is probably due to mechanical obstruction of the openings of sweat glands. There is eruption of small vesicles (blisters) and papules (pimples) which itch so much as to interfere with sleep. The eruption may occur almost anywhere, except the palms of the hands, and is especially found

in the armpits or where the pressure of clothes is felt on the body. The drinking of hot fluids, or excess of alcohol, exposure to the sun, and wearing warm clothing are aggravating factors. (See also under Heat exhaustion above.) Probably the best treatment is calamine lotion, with 10 - 15 grains of sublimed or precipitated sulphur in every ounce, applied frequently.

It is common in unacclimatized people, though some never become acclimatized to this condition.

(i) Cacophoria tropicalis

This condition of "ill feeling" has been named and described by Castellani. It is characterized by lassitude, fatigue and a feeling of ill-health, but without nervous symptoms or irritability. Castellani ascribes it to the climatic effect on the endocrine glands.*

(j) Chills

Persons living in a moist and hot but equable tropical climate are very susceptible to any fall in temperature, especially if it is sudden. They are thus prone to "chills". They are also sensitive to cold draughts and the blast produced by powerful electric fans which will often cause an attack of muscular rheumatism. The danger of wet clothes has already been mentioned.

(k) Intertrigo

This is redness and eczema of the skin produced by excessive sweating. It is especially common in the pubic and armpit (axilla) regions where there may be insufficient evaporation.

(l) Tropical photophobia

Due to the sunlight and glare, may be encountered. Treatment is generally by rest in a darkened room.

(m) Tropical cheiropompholyx

This is a vesicular eruption on the hands, fingers and feet which is common in India. It is probably eczematous but is aggravated by heat and the vesicles remain in the skin for days and often become secondarily infected.

(n) Craw-craw

Craw-craw is the name given to a nodular dermatitis which is common in India, Ceylon and South China. Starting as an itching spot it spreads on the back, chest and arms. Although probably also due to other causes, it is mostly climatic in origin.

(o) Sun dermatitis

Excessive exposure to the violet and ultra-violet light rays will produce a form of dermatitis. This produces painful blisters and peeling of the skin but the new skin growth is less sensitive to the effect of sunshine.

---

* Glands the secretions of which flow directly into the blood, and so can affect distant organs.

(11) Prophylaxis and acclimatization

Under war conditions prophylaxis against the dangers of high atmospheric temperature and humidity is difficult. Due warning of the likelihood of the occurrence of heat-stroke may be obtained by keeping a careful watch of the meteorological conditions. A wet-bulb temperature of 83° F. (28.4° C.) with little or no air movement represents the danger point. These conditions are found on occasion in various parts of the Far East, e.g. South China, Formosa, Burma, etc.

Overloading of troops must be avoided and, so far as is possible, undue fatigue should be prevented.

While there is no question that under ordinary conditions a certain amount of acclimatization is possible within the extreme limits defined, the maintenance of good health and spirits in the tropics demands, as an essential, a good night's sleep and adequate rest, which are not easily obtained in operational conditions.

Times of marching require careful consideration and should be selected so that starts are made sufficiently early to avoid the main heat of the day and yet not too early to interfere unduly with sleep. A sufficiency of the latter is of great importance in the prevention of heat-stroke.

Alcohol must be avoided, at least during the day (until the sun sinks over the yard-arm) and the skin should be kept clean. Clothing should be loose and easy and afford a maximum of ventilation. Dark or tinted glasses give comfort by protecting the eyes from the glare of the sun's rays.

Excessive exercise should be avoided, as the profuse sweating caused thereby, with consequent dehydration and chloride loss, may be the deciding factor in the production of heat-stroke.

Constipation may or may not be a predisposing cause of heat-stroke but it is often an indication of dehydration and the use of strong purgatives should be forbidden owing to the loss of fluid and salt they cause.

The men most likely to develop heat-stroke are those who are unwell; a healthy man in hard training can stand up to almost any climatic heat provided he has plenty of water; and precautions must not be such as to lower morale. It may be possible to establish water-points at centres of traffic and places where troops congregate so that they can readily get cold drinks and a sluice down. Also as loss of salt from the body as a result of excessive sweating is one of the main factors in the production of heat-stroke, its replacement is necessary. This may be effected by the addition of a pinch of common salt to the drinking water (10 grains to the pint). Care should be taken to see that there is a sufficiency of salt in the rations, and it is best given with the meat ration where it is most likely to be taken. The main meal should be in the evening during the hot weather.

In addition to camp and barrack heat-stroke centres, and facilities for the treatment of this disease in hospital, "heat-stroke lorries" have been designed to accompany convoys. Good facilities are needed at hospitals in all hot countries, not only for incoming casualties, but also because febrile patients in the wards are always liable to develop hyperpyrexia. They must be closely watched and immediately treated if deaths from this cause are to be avoided. Tented wards may be particularly hot but can sometimes be cooled with wet brushwood screens or by fans.

In hot-weather surgical operations and anaesthetics should be reduced to a minimum. Certain drugs such as atropine (which hinders sweating), strychnine (a convulsant), thyroid preparations (which increase metabolism) and opium are best avoided or reduced to a minimum.

Some men are constitutionally unable to sweat. These may have to be kept in hospital throughout the hot season, or, better, sent to the hills until the onset of the cool weather.

Acclimatization has been shown in this account to be to some extent possible. It would be advisable for men destined to work in difficult temperatures to be tested as men are for the South African mines. These men are tested in a special room with a wet-bulb temperature of 94° F. and graded according to their reactions and ability to sweat. Water consumption is necessary with the addition of common salt as mentioned above. In an endemic area the allowance should be 3 gallons (11.3 litres) of water per day per man at work, with the addition of salt as recommended by the Medical Officer to counteract salt loss.

In addition the unacclimatized person should use some protection for his head and eyes; he must wear the most suitable clothing, live in sanitary conditions, have a suitable diet at the proper times, and avoid alcohol and exposure to the mid-day sun. According to some authorities the value of a spinal pad is doubtful.

The degree of acclimatization obtainable varies between individuals but even those "acclimatized" cannot afford to disregard the danger limits of temperature and humidity or the warning signs of approaching heat-stroke or sun traumatism.

Complete acclimatization to the humid tropics for a lengthy period for white men is in all probability impossible, as the damp heat eventually proves too debilitating and produces nervous symptoms. It must be noted also that certain Europeans living in the tropics instead of becoming immune to the effects of heat and sun after some years may become more susceptible and after a mild attack sensitized. Indeed in some cases the new arrival is less worried than the old inhabitant who may be debilitated by years of tropical life. Age, too, is a telling factor.

Ladell and his colleagues advise that men in hot climates should be given a holiday after eight weeks of hot weather and where this has been done the results are said to have been excellent.

References

References to the subjects dealt with in this report are very numerous in medical literature. Special reference has been made to the following works which are readily accessible:

Castellani, A. — Climate and Acclimatization, John Bale, 1938.

Dill, D. B. — Life, Heat and Altitude, Harvard University Press, 1938.

Gold, E. — The effect of wind, temperature, humidity and sunshine on the loss of heat of a body at temperature 98° F. Q. J. Royal Met. Soc. vol. 61, 1935, p. 316.

Kendrew, W. G. — Climate 2nd edit. Oxford University Press, 1938.

Kuno, Yas — The Physiology of Human Perspiration Churchill, 1934.

Ladell, Waterlow and Hudson	Desert Climate. Lancet 1944 ii, pp. 491, 527
Manson-Bahr, P	Synopsis of Tropical Medicine Cassell, 1943. Manson's Tropical Diseases Cassell, 1940.
Markham, S. F.	Climate and the Energy of Nations Oxford University Press, 1942.
Marsh F.	Animal Life in Desserts. Lancet, 1945 i. p. 289.
Mills C. A.	Climate makes the Man. Collancz, London 1944.
Rogers and Megaw	Tropical Medicine Churchill, 1942.
Strong R. P.	Stitt's Tropical Diseases 6th edition. Lewis, 1942.
Tytler, W. F.	Bracing and relaxing climates. Q. J. Royal Met. Soc. vol. 61, 1935, p. 309.
War Office	Memoranda on Medical Diseases in Tropical and Sub-Tropical Areas H.M.S.O., 1942.
Ward, R. de Courcy	Climate considered especially in relation to Man London, 1908.